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## MIDDLE SCHOOL

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## OBSERVATION

**Module C**  
**The Amazing Transformations of Water**  
**(Grades 5–9)**

## Lesson 8: Snow

### Objective

Help students physically and intellectually understand how snow is a very important part of the water cycle in the Caucasus Mountains.

### Background information

Use the information below as a basis for a lesson for middle and upper level students.

*What are snowflakes and snow crystals?*

Snowflakes and snow crystals are made of ice, nothing more. A snow crystal, as the name implies, is a single crystal of ice. A snowflake is a more general term, which can mean an individual snow crystal, a few snow crystals stuck together, all the way up to the large “puff-balls” of agglomerated snow crystals that often fall in warmer weather.

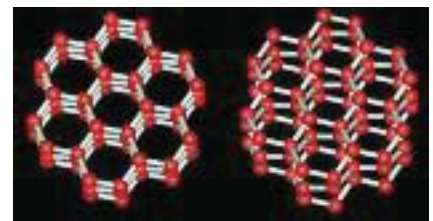


*What exactly is an ice crystal?*

A crystal is a material for which the molecules inside are all lined up in a specific way called a crystal lattice. The water molecules in ice form a hexagonal lattice as shown in this image (two views of the same thing). Each red ball represents an oxygen atom, and the grey sticks represent hydrogen atoms. There are two hydrogen atoms for each oxygen atom, making the usual  $H_2O$ .

*Are snow crystals the same as frozen raindrops?*

No. Sometimes raindrops do freeze as they fall, but this is called sleet. Sleet particles don't have any of the elaborate patterns found in snow crystals. Snow crystals form when water vapor condenses directly into ice, which happens in the clouds. The beautiful snow crystal patterns form as the crystal grows.



### Activities for Students of All Ages

#### 1. Sculpt It!

The presence of air in snow can lead to a discussion of snow as a shelter for wildlife (the trapped air insulates). Building snow shelters, even if squirrel-sized, is something that can help students understand snow as habitat. This leads to a lesson on winter wildlife adaptations where students work in teams to create snow figures of animals and discuss their survival abilities in this habitat.

You may have a gallery showing afterwards, with each group sharing facts and thoughts about their character's adaptations, ecological niche, etc. You may invite parents and family members to stop by the outdoor sculpture gallery for an after-school visit to increase parent participation in the school's activities.

#### 2. Is Snow Edible?

Some students like eating snow . . . how about finding out what is in the snow? Bring in some samples from different layers of the snow and melt them on a burner, then pass the resulting water samples through white coffee filters. Students are always amazed at the amount of dirt even in seemingly white snow. This powerful demonstration of air pollution will certainly deter them from eating snow again! Use this opportunity to ask them where this pollution may have come from. List sources of air pollution on the chalkboard.

To illustrate the pureness of fresh, untouched snow, a learning activity can be made into a special treat. Using pure snow collected in clean food containers, you can add food coloring and sugar to make sweet snow cones!

#### 3. Dig It!

Making a snow pit can be very interesting—you can see and measure different layers of snow, estimate how many storms that represents, look at the metamorphosis of snow in different layers, estimate water content, etc.

To estimate water content of the snow, take a graduated cylinder (or just a jar or cup) and fill it with snow from a particular layer, trying not to pack it more than it already is. Have students estimate how much water there will be in the cylinder after the snow melts.

Students are always amazed at how little water there is in snow! Once you have dug your snow pit and taken measurements, you could use the pit as the start of a snow shelter if you have time—just remember to make ventilation holes.

\* Adapted from Maggie Snow, Los Angeles County Outdoor Science School, Wrightwood, CA, 2004. Snow Flake Field Guide available online at <http://www.snowcrystals.com>

## Lesson 9: Eco-Detective: The Case of the Disappearing Water (Grades 5–7)

Keywords: evaporation, water cycle, phase, variable, pollutants

Objective

Explain and demonstrate the phenomenon of “evaporation.” Explain evaporation in the context of the water cycle.

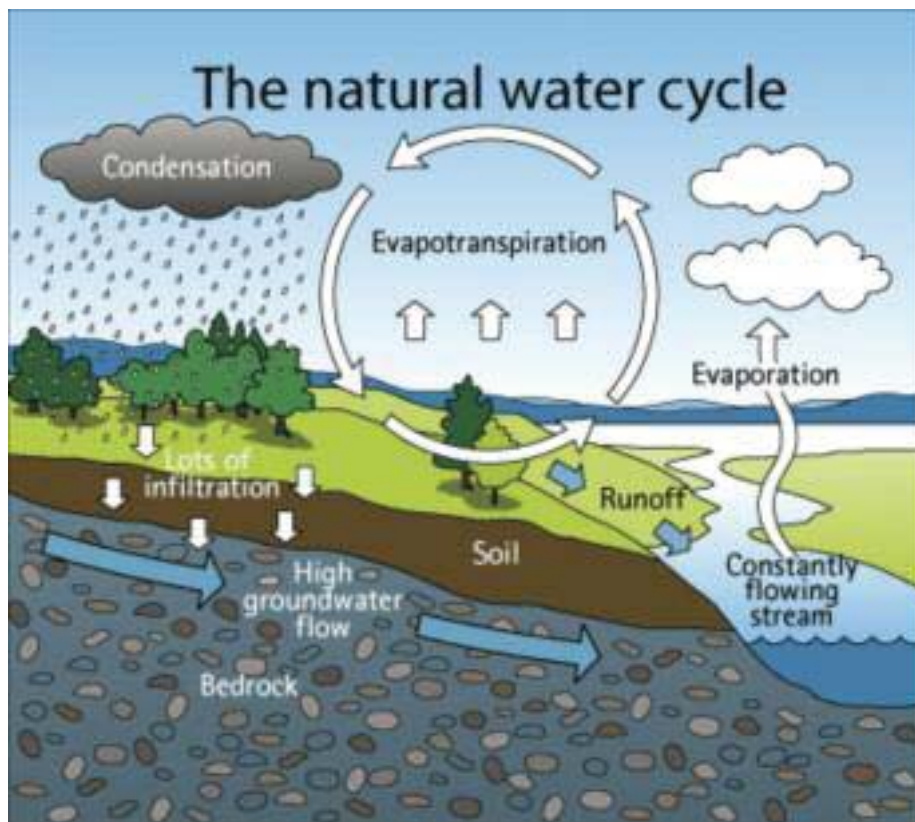
### Background information

Water exists in three states: solid, liquid, and gas. These states are often referred to as phases. As heat is added or removed, water goes through a phase change. In its solid phase, water molecules are structured and orderly. In its gaseous phase, water molecules lack structure and order.

Transformation of water into its gaseous, or vapor phase is a natural process facilitated by the heat of the sun. Likewise, when we boil water over a burner we are causing it to change from a liquid to a gas. The process by which a substance changes from a liquid to a gas is called evaporation. The reverse process is called condensation.

Water is continuously being heated and cooled—evaporating, condensing, and freezing—depending on the environmental circumstances. As water travels in its never-ending cycle between the earth and the sky, it encounters and mixes with a variety of substances. Some of these substances are pollutants, in the sense that they are harmful to living things. Pollution can occur both naturally and through human activities.

Through the water cycle, nature provides a variety of mechanisms to clean water. For example, evaporation is a natural water cleanser. When water evaporates, it leaves most dissolved substances and waste materials behind. Pollution can also be filtered out as water moves through soil or as wetland plants absorb metals and other pollutants.



What do you need?

- Clear measuring cup or glass bottle with clearly marked measurements
- Water
- Copies of the story and the student assignment handout or the information written on the chalkboard

What do you do?

- Tell the students that they are going to be “water detectives” who are being asked to solve the case of the disappearing water
- Allow students to read “The Case of the Disappearing Water”
- Coach students as necessary to complete the assignment, but encourage independent thinking as much as possible
- Make sure students develop a hypothesis before beginning the experiment
- Make sure students remember to check the water level each day

### **Experiment**

Perform an experiment to establish approximately how long it took for the water to evaporate.

- a. Write down today’s date
- b. Fill a measuring cup to the one cup line
- c. Put the cup in a sunny window
- d. Record how many days it takes for the water in the measuring cup to be at the three-quarter cup line

Tips for the teacher

- Make sure students check the water level each day
- When the experiment is over, be sure students record their results and conclusions
- You may have students work individually or in small groups

Follow-up questions

For what reason might the results of each group’s experiment differ? Environmental variables may have affected the outcome, such as one group’s measuring cup may be more exposed to sunlight than the others’.

Suppose that during the day Mrs. Anahit was gone the weather was sunny and hot; however, when the detectives conducted their experiment the weather was cloudy and cool. How would this variable affect the experiment?

What is a variable? Something that is not constant, or is subject to change in the experiment.

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\* Adapted from <http://www.epa.gov/region01/students>

## The Case of the Disappearing Water

Originally written by Susan M. McMaster, USA

*The Water Detectives were called to the home of Mrs. Anahit. When they arrived on the scene, Mrs. Anahit's son Armen was very upset. His mother was missing! The detectives asked Armen how long had his mother been missing.*

*"That is the problem. I do not know!" Armen said. "I have been working very hard in Yakutia and I just came to visit my mother. Now I feel terrible. I have no idea how long she has been missing."*

*"Do you know of some places where she might have gone?" asked one water detective.*

*Armen wrinkled his brow and thought hard. "Well," he said, "her habits are very predictable. If she has been gone for less than a day, she probably just went shopping. If she has been gone for less than three days, she may be visiting one of her sisters in another region. She always says, 'Guests are like fish, they start to stink in three days!' If she has been gone more than three days, but less than seven," Armen continued, "she is probably taking a vacation. I am sure that she cannot afford more than a seven-day trip. If she has been gone more than seven days but less than six weeks, she probably received the grant she applied for to travel and study in the United States. If she has been gone more than six weeks, she probably is in the regions. She never stays there more than two months. If she has been gone longer than two months, aliens must have captured her and taken her to another galaxy. She loves her plants and her home. She would never stay away longer than two months for any reason."*

*"I think we can solve your mystery," said one water detective walking around the house.*

*"Did you find a note?" asked Armen hopefully.*

*"No," said the detective, "but I did find this glass measuring cup in the window."*

*"Oh," said Armen, "that's nothing. Mother is very particular. Every morning she fills the measuring cup to exactly one cup. Then she puts it in the window to warm in the sun a little before she waters her African violets. She is very careful about how much water she uses because she doesn't want to over-water or under-water her plants."*

*"Aha!" said the water detective. "Just what I suspected, this is precisely where we must begin our search. The measuring cup now has exactly three-quarters of a cup of water."*

*"Are you saying someone stole one-quarter of a cup of water?" Armen asked. "What has this to do with my mother being missing?"*

*"No wonder his mother didn't bother to tell him where she was going!" muttered one of the detectives.*

*"No, sir," said another detective trying to keep a straight face. "It is a matter of evaporation. As water evaporates into the atmosphere, the warmth of the sun changes the clear liquid into water vapor that we can't see. After a while the water vapor condenses and forms into clouds. Eventually, the water comes back to the ground as rain and snow or hail. Over time the water evaporates again. It is all part of the water cycle."*

*"To make a long story short," said another water detective. "We are going to conduct an experiment. We'll put a cup of water in a sunny place and keep track of how long it takes to evaporate. Based on the experiment, we will estimate how long ago Mrs. Anahit left the measuring cup in the window."*

*"What a relief," said Armen. "What should I do now?"*

*"I suggest you water the plants," replied another detective.*

**Handout: Student Assignment**

1. Write down the facts of case.

a. Original amount of water in the measuring cup \_\_\_\_\_

b. Amount of water in the measuring cup now \_\_\_\_\_

2. Write down where Armen said his mother might be.

a. If Mrs. Anahit was gone less than a day, she probably \_\_\_\_\_

\_\_\_\_\_

b. If she has been gone less than three days, she may be \_\_\_\_\_

\_\_\_\_\_

c. If she has been gone more than three days but less than seven days, she probably \_\_\_\_\_

\_\_\_\_\_

d. If she has been gone more than seven days but less than six weeks, she may be \_\_\_\_\_

\_\_\_\_\_

e. If it has been more than six weeks but less than two months, she is \_\_\_\_\_

\_\_\_\_\_

f. If she has been gone for more than two months \_\_\_\_\_

\_\_\_\_\_

3. Develop a hypothesis (educated guess): Describe what you think will happen when you do the experiment.

a. How long do you think the water was left on the window sill? \_\_\_\_\_

b. Where do you think Mrs. Anahit went? \_\_\_\_\_

4. Write your conclusions.

a. It took approximately \_\_\_\_\_ days for the water to evaporate.

b. Where should Armen begin looking for his mother? \_\_\_\_\_

5. Make notes about your observations in a special water detective's notebook.

## Lesson 10: Local Water Resources (Grades 7–9)

Author: Margarita Khachatryan, biology teacher, Yerevan Secondary School No. 154

### Lesson 10.1: Drinking Water and Its Significance

#### Objective

Students should learn about water resources on the planet, learn how to save water, and appreciate the role of water in nature and in human life.

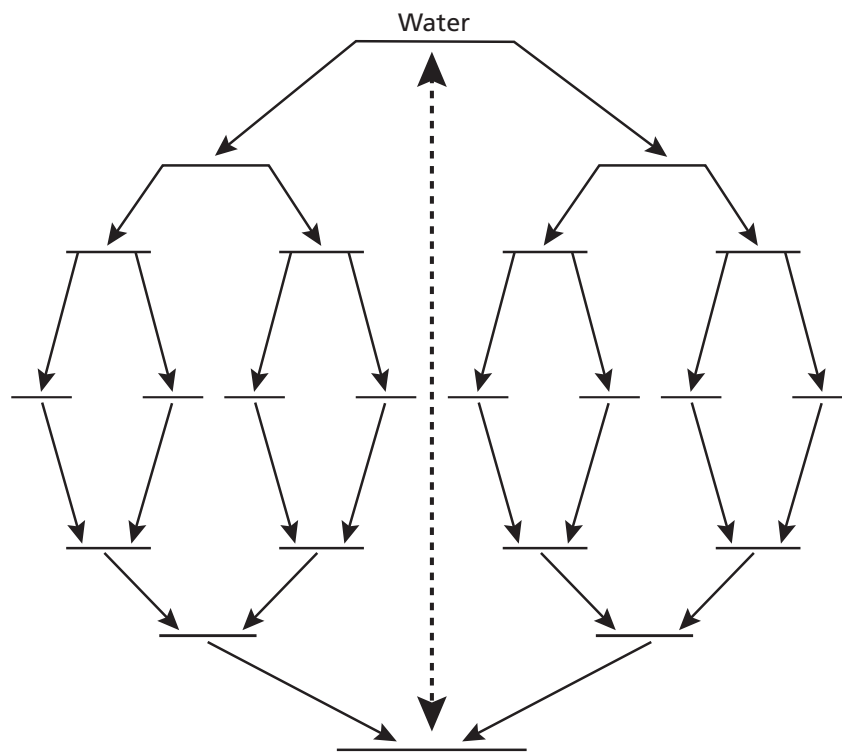
#### Warm Up Riddles

1. It flows from under the ground but faces the sky (Answer: spring)
2. They can fly without wings, walk without feet, and navigate without sails (Answer: clouds)
3. You can see it when nothing else is visible (Answer: mist)

#### Stimulation

The teacher asks, “What associations do you make when you hear the word ‘water?’” and writes the students’ responses on the chalkboard. Students write the word “water” at the top of the prism and a string of sequentially associated words on the levels below as the chart fans out.

The teacher then asks students to refocus their associations for fewer words, so that the final word is closely related to “water,” for example “life.” Finally, students are asked to explain the association of the words—especially “water”—to the last word by making up sentences using those words.



### Guided Reading: Freshwater Supplies

Undoubtedly there is no life without water.

When searching for evidence of life on other planets, researchers first try to find out if there is water.

By absorbing and releasing heat, water moderates the Earth’s climate. Water molecules, scattered in the atmosphere, protect us from cosmic frost. Water vapor, creating a temperature buffer in the atmosphere, causes the greenhouse effect.

*Pause 1*

## Questions

1. Is water an unlimited resource?
2. What are the causes of freshwater scarcity?

The volume of water on the whole planet is 1,390 million cubic kilometers. If the Earth were covered with an even layer of water, it would be four kilometers high. As a result of human activities, water quantities lessen substantially each day or become unusable after being contaminated with harmful substances.

Freshwater is the most essential component of all kinds of living organisms. The volume of freshwater on our planet is 20 million cubic kilometers. Almost all the fresh water supplies (97 percent) are found in the ice fields of the Arctic Ocean and Antarctica. Thus, only three percent of freshwater supplies—distributed unevenly—are available for human use. This is the reason why most countries of the world lack access to safe drinking water and live in unhealthy and hazardous conditions.

### *Pause 2*

## Questions

1. Which are the main water basins in Armenia?
2. Where does our drinking water come from?

Armenia's lakes and rivers are essential sources of hydropower, irrigation, and water supplies. For Armenian farmers irrigation water is the most valuable thing. In Armenia 2.5–3 billion cubic meters of water is utilized annually, about 2 billion cubic meters of which is used for irrigation.

In Armenia there are three main water sources: the River Araks, the River Kour, and Lake Sevan. There are over 215 streams with a length of 10 kilometers or more. Armenia's other major rivers are the Akhouryan, Hrazdan, Azat, Arpin, Vorotan, Debed, and Aghstef.

Lake Sevan—the largest lake in Armenia—is one of the highest freshwater lakes in the world. Lake Sevan is of strategic significance to Armenia since it supplies drinking water for Armenia.

Sevan's waters, passing natural rock formations, get filtered and then come out in the form of clean water springs in thousands of spots all over Armenia. Sevan's water is also used for irrigation covering the area from Gegharkunik Marz all the way through the Ararat Valley.

Armenia is rich in groundwater which is also used for daily purposes.

### *Pause 3*

## Question

1. What important role do freshwater supplies have in human and animal life?

Every cell in the human organism contains water. People can survive without water only for a few days. Water is part of every kind of bodily activity; it gets nutritious substances and oxygen to move, releases decomposed substances, functions as part of the breathing process, has a thermostatic effect, etc.

## **Lesson 10.2: Forms of Water Contamination**

### Objective

Students should learn about causes of water contamination and understand that clean water is essential.

### What do you do?

Take two glasses full of water—one is filled with tap water and the other with water from a nearby stream. Ask students to describe both clean and contaminated water and guess how the stream water is contaminated and what the causes are.

Read “The Causes and Consequences of Water Contamination” and ask students to write four questions they are concerned about in the sections of the grid called “Diary with Double Notes.” In the first column there should be a quote from the text; in the second column they should write their own opinion about it.



## Homework assignment

In groups of two–three students, collect information on:

1. The sources of the tap water in their homes (well, river, lake?)
2. The causes of water pollution in the nearby rivers or reservoirs in their area

## Reading: The Causes and Consequences of Water Contamination

We learned from the previous lesson how important water is. However, today humanity is threatened by a scarcity of clean, safe water because for centuries people have been dumping household and industrial waste into rivers, lakes, and seas. Fresh water supplies are of strategic significance for any country.

Fresh water is classified in three groups according to the degree of contamination:

1. High degree of contamination
2. Medium degree of contamination
3. Almost clean

Water contamination is caused by harmful substances found in industrial waste water. Passing through the food chain, water pollutants affect flora and fauna and eventually humans.

Today over a billion people lack access to safe drinking water and about one billion people live without basic sanitation. Contaminated water kills millions of people each year.

Waste water from oil treatment, cellulose, paper, and chemical industries are particularly dangerous for water quality. Water contamination has become a critical issue worldwide.

### Contamination with household/municipal water discharge

Water bodies are largely contaminated with untreated water discharged from bathhouses, hospitals, canteens, and other public institutions. Today the Mediterranean, North Sea, and Baltic Sea are severely contaminated.

### Contamination with heavy metals

Living organisms are seriously affected by large quantities of heavy metals (mercury, copper, and lead) found in water. Certain algae, due to their specific properties, can absorb these metals in large quantities. Fish, crustaceans, and gastropods, which feed on these algae, accumulate heavy metals in their bodies. Then people may eat these sea creatures.

### Oil contamination

As a result of oil drilling, the bottom of the sea becomes polluted. While being transported by sea, thousands of tons of oil are released into the water, which causes contamination. Layers of oil cover the surface of the water, which affects the energy, temperature, humidity, and gas exchange between the atmosphere and the hydrosphere. This phenomenon greatly affects water plants and large and small creatures. A ton of oil creates a layer as large as 12 square kilometers. Each year about 6,000 ships transport 3.5 billion tons of oil. In the last decade more than 750 ships had accidents in the oceans.

### Contamination with toxic chemicals

The world oceans are polluted with pesticides also. They get into the soil and reach the sea through run-off water. These toxic chemicals often cause massive destruction of fish.

### Contamination with nuclear waste

Nuclear waste, which is generated as a result of nuclear power production, various accidents, leakages, as well as testing nuclear arms, causes water contamination.

Fresh water supplies are scarce all over the world and in the Caucasus in particular.

Before reaching us, water undergoes a number of processes. Developed industrial countries have built water treatment stations. They also have improved production technologies to minimize water pollution. In addition, they may use closed water supply systems which allow use of the same water many times. In the case of low contamination levels, water in natural basins may clean itself—this can be an effective but slow process.

At present industries and agriculture are accountable for huge amount of water contamination. The only way to clean this water is by large treatment facilities, which are rare in Armenia.

Industrial wastewater undergoes physical and biological purification processes. Water treatment is conducted by ozone, chlorination, aeration, and ultrasound. In biological treatment, water organisms such as amoebas, infusorians, mollusks, or worms are used.

If drinking water contains pathogen microorganisms, then it undergoes chlorination and ozone treatment. Drinking water must be free from pollutants and be safe for human health.

You have the right to know that you drink clean and safe water.

### Diary with Double Notes

Quote from the text	What you think of it
1.	
2.	
3.	
4.	

### References

1. Armenian Landscape, *Family Encyclopedia*, Yerevan, 2006.
2. *We and Our Planet*, Khazer NGO, 2006.
3. *Let's Live on a Healthy Planet*, K. Matevosova.